

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
29 September 2005 (29.09.2005)

PCT

(10) International Publication Number
WO 2005/091029 A3

(51) International Patent Classification:

G02B 6/16 (2006.01) *G02B 6/28* (2006.01)
G02B 6/22 (2006.01) *H01S 3/067* (2006.01)
G02B 6/26 (2006.01)

(21) International Application Number:

PCT/DK2005/000192

(22) International Filing Date: 21 March 2005 (21.03.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

PA 2004 00447	19 March 2004 (19.03.2004)	DK
60/554,373	19 March 2004 (19.03.2004)	US
PA 2004 00844	28 May 2004 (28.05.2004)	DK
60/575,091	28 May 2004 (28.05.2004)	US

(63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:

US 60/575,091 (CON)
Filed on 28 May 2004 (28.05.2004)

(71) Applicant (for all designated States except US): **CRYSTAL FIBRE A/S** [DK/DK]; Blokken 84, 3460 Birkerød (DK).

(72) Inventors; and

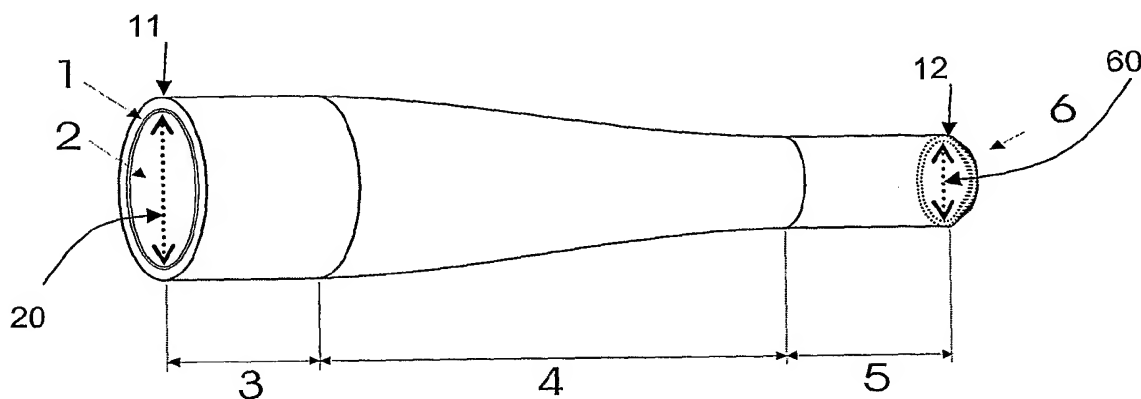
(75) Inventors/Applicants (for US only): **NIELSEN, Martin** Dybendal [DK/DK]; S. Willumsensvej 9, DK-2800 Kgs. Lyngby (DK). **SKOVGAARD, Peter, M.W.** [DK/DK]; Mosevangen 16, DK-3460 Birkerød (DK). **BROENG, Jes** [DK/DK]; Trudeslund 14, DK- 3460 Birkerød (DK). **VIENNE, Guillaume** [FR/CN]; c/o The Chinese University of Hong Kong, Center for Advanced Research in Photonics, Department of Electronic Engineering, Shatin, NT Hong Kong (CN).

(74) Agent: **NKT RESEARCH & INNOVATION A/S**; Group IP, Blokken 84, DK-3460 Birkerød (DK).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US (patent), UZ, VC, VN, YU, ZA, ZM, ZW.

[Continued on next page]

(54) Title: OPTICAL COUPLER DEVICES, METHODS OF THEIR PRODUCTION AND USE



(57) Abstract: The present invention relates in general to coupling of light from one or more input waveguides to an output waveguide or output section of a waveguide having other physical dimensions and/or optical properties than the input waveguide or waveguides. The invention relates to an optical component in the form of a photonic crystal fibre for coupling light from one component/system with a given numerical aperture to another component/system with another numerical aperture. The invention further relates to methods of producing the optical component, and articles comprising the optical component, and to the use of the optical component. The invention further relates to an optical component comprising a bundle of input fibres that are tapered and fused together to form an input coupler e.g. for coupling light from several light sources into a single waveguide. The invention still further relates to the control of the spatial extension of a guided mode (e.g. a mode-field diameter) of an optical beam in an optical fibre. The invention relates to a tapered longitudinally extending optical waveguide having a relatively larger crosssection that over a certain longitudinal distance is tapered down to a relatively smaller cross section wherein the spatial extent of the guided mode is substantially constant or expanding from the relatively larger to the relatively smaller waveguide cross section. The invention may e.g. be useful in applications such as fibre lasers or amplifiers, where light must be coupled efficiently from pump sources to a double clad fibre.



WO 2005/091029 A3



(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) **Date of publication of the international search report:**
26 January 2006

(15) **Information about Correction:**

Previous Correction:

see PCT Gazette No. 43/2005 of 27 October 2005, Section II

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.